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Rocket Ozone Sounding Network Data

Quarterly Report

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National Aeronautics and
Space Administration

Wallops Flight Center
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Quarterly Report for the Period March 1977 through May 1977

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PREFACE

The objectives of the rocket ozone program are to: (1) determine seasonal and annual variations of ozone, above balloon altitudes, for use in atmospheric modeling; (2) provide calibration/validation data for satellite experiments; and (3) measure ozone changes associated with specific energy or momentum inputs to the atmosphere in conjunction with other experimenters on an expeditionary basis.

The launch vehicle configuration for the rocket ozonesonde is described as an unstable Super Loki with 2-1/8 inch diameter Dart and 7-1/2 foot starute. The combination of standard components provide the rocket ozonesonde with a nominal apogee of 70 km and the ability to measure ozone profiles to as high as 67 km.

The Super Loki booster burns for 1.8 seconds; at which time it separates by drag from the Dart which continues in its ballistic trajectory to apogee. At the time of booster burn out, the Super Loki vehicle (both Dart and booster) typically reaches 1.52 km and has a velocity of 1628 m/sec. The booster becomes completely unstable at drag separation and has an impact dispersion which, in some situations, is inappropriately large. In those situations where less impact dispersion is dictated, such as the standard requirement of water impact at Wallops Flight Center, and better control of impact, such as the restricted impact zone at Antigua, West Indies, 3.4 kg additional weight is added at the booster headcap. The result is the stable Super Loki which meets the requirements but lessens the rocket ozone apogee to approximately 58 km. The compromised performance proportionately reduces the upper altitude limit of the rocket ozone profiles. Therefore, the unstable Super Loki is used wherever possible.

The ozone rocket activities described in this report are a part of a cooperative effort between the Goddard Space Flight Center and Wallops Flight Center in support of Environmental Quality and Weather and Climate Program Discipline Objectives (Office of Space and Terrestrial Applications). The efforts to date will form a strong data and operational planning base for correlative support of remote sensors to be flown in the near future on Nimbus-G and the AEM/SAGE satellite platforms. It is anticipated that the program will continue into the 1980's in support of Shuttle launched atmospheric research and monitoring satellites and sensor systems, and in the pursuit of unique research objectives not possible to achieve from satellite systems alone.

Quarterly reports are published to provide flight operations and reduced data records for the scientific community. Formal scientific reports will be published at less frequent intervals.

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ROCKET OZONE SOUNDING NETWORK DATA QUARTERLY REPORT

D. U. Wright, A. J. Krueger, and G. M. Foster

INTRODUCTION

Rocket ozone flights are scheduled for local apparent noon plus or minus one hour on World Days (March 16, April 20 and May 18, 1977) according to the International Geophysical Calendar. Back-up flights are scheduled for the same time period the following day or priority days the following week. During the period March through May 1977, seven (7) rocket ozonesondes were expended: one (1) provided calibration/validation data for the Backscatter Ultraviolet (BUV) instrument on Nimbus-4, six (6) were normal Network/World Day launches--three (3) from Wallops Flight Center and three (3) from the Churchill Research Range. Of the six Network/World Day launches, five (5) were successful.

This quarterly report contains discussions and tabulation sheets and plots for each rocket ozone flight plus all associated support data presented in sequence, by station, according to flight number. A chronologically ordered Flight/Data Log Summary, which identifies the flights, as well as all associated support data that are discussed and/or used in reducing the flight data for this reporting period, is presented in Table I.

The discussions include a flight synopsis and the results of the data reduction processes. The synopsis gives a brief picture of the flight and its quality, as well as the atmospheric and dynamics environment encountered by the payload. The discussion of results presents a tabulation of the Solar Flux Values/Filter Characteristics where:

S_i is the filter I.D. (i = 0, 1, 2, 3).
λ is center of wavelength for the corresponding filter.
$\Delta\lambda$ is the full width at half the peak transmission (FWHM).
TM (volts) is the average signal level determined shortly after the starute stabilized.

Thermodynamic data measured by the supporting rocket and balloon flights, in support of the rocket ozonesonde flights, are reported, independently, in the monthly World Data Center A Meteorology Data Reports (High Altitude Meteorological Data) published by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Center, Asheville, NC 28801, USA.

TABLE I.-FLIGHT/DATA LOG SUMMARY

Flight No.	Launch Time T-0 (GMT)	Date	Range Model No.	Remarks
WFC	37.85°N 75.48°W			
	1500/1715/1924	3/16/77		Dobson
	1520	3/16/77	T1-8755	Datasonde[1]
149	1700	3/16/77	T1-8416	Optical Ozonesonde
	1752	3/16/77		ECC Ozonesonde[2]
	1400	4/1/77		ECC Ozonesonde
151	1440	4/1/77	T1-8722	Optical Ozonesonde
	1448/1718/1950	4/1/77		Dobson
	1533	4/1/77	T1-8763	Datasonde
	1326	4/20/77		ECC Ozonesonde
	1446/1714/2003	4/20/77		Dobson
	1552	4/20/77	T1-8766	Datasonde
152	1656	4/20/77	T1-8721	Optical Ozonesonde
	1328	5/18/77		ECC Ozonesonde
	1509/1729/2003	5/18/77		Dobson
154	1638	5/18/77	T1-8723	Optical Ozonesonde
	1702	5/18/77	T1-8872	Datasonde
CRR	58.75°N 94.07°W			
	1613	3/16/77		MAST Ozonesonde[3]
	1613	3/16/77		Datasonde
	1800	3/16/77		Dobson
150	1819	3/16/77	TH1-8709	Optical Ozonesonde
	1616	4/20/77		Datasonde
	1700	4/20/77		MAST Ozonesonde
153	1800	4/20/77	TH1-8710	Optical Ozonesonde
	1800	4/20/77		Dobson
	1100	5/18/77		MAST Ozonesonde
	1633	5/18/77		Datasonde
	1800	5/18/77		Dobson
155	1813	5/18/77	TH1-8711	Optical Ozonesonde

[1] Indicates that either a Super Loki Datasonde (WFC) or a Loki Datasonde (CRR) was used to collect the standard thermodynamic data.

[2] Indicates a Radiosonde balloon plus Electrochemical Concentration Cell (ECC) was used to collect lower altitude ozone profile data and "tie-in" pressure reference.

[3] Indicates an instrument used by Canada for the same purpose as the ECC ozonesonde.

Statistical thermodynamic data, when used, are from the current World Data Center A Meteorology Data Report (High Altitude Meteorological Data) Quarterly Issue published by the same office.

Total ozone and balloon ozone data measured in support of the rocket ozonesonde launches are reported, independently, in the Ozone Data for the World (bimonthly) reports published by the World Ozone Data Centre, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, Canada M3H 5T4.

FIFTH QUARTER OPERATIONS

Flight No. 149 (Wallops Flight Center/World Day)

Synopsis.-Rocket ozonesonde flight No. 149, launched at 1700 GMT on March 16, 1977, reached an apogee of 71.0 km at T+120 seconds. Ejection occurred at T+116 seconds. The recording of meaningful telemetry and radar data was initiated at T+162 seconds. Flight data were recorded for 50 minutes.

The short term (seconds) noise in the UV signals (S_0, S_1, S_2, and S_3) at T+240 seconds is approximately 200 millivolts. The longer term (minutes) noise in the data, at approximately the same time, was slightly greater than 300 millivolts. The highest frequency component observable on the compensation channel (Channel 3) had the typical half second period. Earlier in flight, the TM modulation, due to starute pendulation/coning, varies from one volt peak-to-peak to a maximum of three volts peak-to-peak. At lower altitude, toward the end of recorded data, the modulation varies from two volts peak-to-peak to a maximum of three and a half volts peak-to-peak.

After decelerator stabilization, all UV channels indicated reasonable signal levels. S_0 was 6.2 volts. S_1 was 7.9 volts. The compensation channel was 6 to 7 volts. S_2 was 6.6 volts. S_3 was 6.2 volts.

Flight Results.-The Solar Flux Values and Filter Characteristics for flight 149 are presented in Table II. The data were reduced over a 50 km height interval from 16 km to 66 km. In the overlap region data from S_2 and S_3 signals (43 to 48 km), the ozone densities from S_3 were 2% higher than the S_2 results. In the overlap region between S_1 and S_2 (37 to 38 km), the S_2 results were 16% less than the S_1 ozone densities. The merged results are given in Table III. Data errors become very large above 56 km due to the small absorption per unit height with the particular solar zenith angle conditions for this flight. The errors also increase below 21 km due to the reduction in S_1 signal level at large ozone optical depths. The integrated ozone amount above 25.5 km is 0.128

TABLE II.-SOLAR FLUX VALUE/FILTER CHARACTERISTICS FOR FLIGHT NO. 149

TM CHANNEL ($\#/S/\lambda/\Delta\lambda$)	TM (VOLTS)	$I(\infty)$	OZONE PROFILE INTERVAL (km)
$\#1/S_0/3198.3/33.8$	6.2	83	REFERENCE
$\#2/S_1/3036.0/35.4$	7.9	64	16-39
$\#4/S_2/2828.2/39.3$	6.6	26	36-49
$\#5/S_3/2577.7/123.5$	6.2	13	42-66

POLYNOMIAL COEFFICIENTS FOR α AND β

S_i	A_0	A_1	A_2	C_0
S_0	0.632	-0.013	0.000	0.927
S_1	5.719	-0.507	0.076	1.156
S_2	81.26	-46.65	-19.4	1.56
S_3	267.2	-954.	-68300.	2.21

NOTE: λ and $\Delta\lambda$ are expressed in Å, $I(\infty)$ is expressed in $\mu W/cm^2/nm$.

atm-cm, which, when added to the amount detected by the ECC balloon ozonesonde below this altitude, 0.252 atm-cm, yields a total ozone value of 0.380 atm-cm. The Dobson reading, taken through thin cirrus, was 0.327 atm-cm, or 14% lower than the sounding integral.

The ozone density profile is shown in Figure 1. Above 40 km, the profile is very close to a constant scale height (4.00 km) distribution. This is replaced at lower altitudes with a slightly structured curve having a maximum at 21.5 km. Relative to the mid latitude model, this profile has lower densities in the constant scale height region but higher densities in the lower altitudes. The mixing ratio profile (Figure 2) has a maximum of 14.8 $\mu g/g$ at 34 km and structure at 37 and 38 km. The structure appears related to the crossover between S_1 and S_2 data and may not be real. The ECC balloon ozonesonde data, also shown in Figure 2, shows very close agreement with the rocket data from 20 km to 35 km, including the maximum at 34 km. Above 35 km, the balloon instrument appears to lose sensitivity, probably because of the low air pressure ($<$ 6 mb).

The air temperature soundings from the 1530 GMT Datasonde flight and the 1752 GMT radiosonde are plotted in Figure 3. These profiles have a very cold upper tropopause at 17.5 km, a relatively constant gradient across the stratosphere and a nearly isothermal stratopause region from 44 km to 62 km.

TABLE III.-COMPOSITE RESULTS

ROCKET OZONE DATA

Flight No 149 Location Wallops Rocket Total Ozone Above 25.5 km
Equals .128

Date 3/16/77 Experimenter A. Krueger Balloon Residual Ozone Below 25.5 km
GMT Time 1700 GMT Equals .252
Ser. No's: Sensor/PCM/Starute: 223/760846/S14860 Total Ozone = .380
Sec Z = 1.3002
= 1.3002 Scale Height = 4.0 Dob. on Total Ozone = .327
= 1.3004

Ht km	$\Delta x/\Delta h$ atm-cm/km	Probable Error, %	x(h) atm cm	E(h) mol/cm³	Mixing Ratio ugm/gm	O_3 Partial Pressure umb	Air Temp °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66			.000044						
65	.000011	339	.000055	2.96×10^9	1.4	.100	-29	.115	
64	.000013	233	.000068	3.49	1.5	.120	-26	.132	1.10
63	.000011	325	.000079	2.96	1.1	.104	-21	.153	
62	.000013	260	.000092	3.49	1.3	.127	-13	.162	.73
61	.000018	186	.00011	4.84	1.6	.175	-14	.184	
60	.000018	195	.00013	4.84	1.4	.173	-16	.209	.66
59	.000023	156	.00015	6.18	1.5	.223	-14	.238	
58	.000025	142	.00018	6.72	1.5	.242	-15	.271	.60
57	.000033	111	.00021	8.87	1.7	.324	-11	.309	
56	.000045	78	.00025	1.21×10^{10}	2.1	.446	- 8	.351	.75
55	.000056	65	.00031	1.51	2.2	.543	-14	.398	
54	.000075	49	.00039	2.02	2.6	.730	- 13	.453	.79
53	.00010	40	.00049	2.69	3.1	.962	-16	.516	
52	.00012	31	.00061	3.23	3.2	1.15	-17	.588	.84
51	.00016	26	.00077	4.30	3.8	1.54	-16	.671	
50	.00019	21	.00096	5.11	4.0	1.85	-13	.753	.77
49	.00025	17	.00121	6.72	3.2	2.42	-14	.869	
48	.00033	11	.00154	8.87	5.4	3.22	-12	.989	.86
47	.00042	09	.00196	1.13×10^{11}	5.9	4.03	- 17	1.13	
46	.00056	07	.00252	1.51	6.9	5.41	-15	1.29	.89
45	.00072	05	.00324	1.94	7.8	6.98	-14	1.46	
44	.00072	05	.00416	2.47	8.8	8.96	-13	1.66	.90
43	.00120	05	.00536	3.23	9.8	11.3	-21	1.90	
42	.00142	06	.00678	3.82	9.9	13.1	-26	2.17	.96
41	.00185	04	.00863	4.97	11.2	16.9	-29	2.49	
40	.0023[illegible]	04	.0110	6.34	12.5	21.7	-27	2.86	1.04
39	.0027[illegible]	04	.0138	7.47	12.8	25.5	-28	3.28	
38	.00294	06	.0167	7.90	11.8	27.1	-27	3.76	.90
37	.00336	07	.0201	9.03	11.6	30.6	-30	4.32	
36	.00457	22	.0246	1.23×10^{12}	13.6	41.1	-33	4.96	1.01
35	.00538	19	.0300	1.45	13.9	48.3	-33	5.71	
34	.00676	15	.0368	1.82	14.8	58.2	-39	6.58	1.15
33	.00782	12	.0446	2.10	14.4	67.3	-43	7.61	
32	.00845	11	.0531	2.27	13.5	72.8	-43	8.82	1.12
31	.00915	10	.0622	2.46	12.6	78.1	-45	10.2	
30	.0103	10	.0725	2.77	12.2	87.9	-45	11.9	1.10
29	.0117	09	.0842	3.14	11.8	99.0	- 47	13.8	
28	.0130	09	.0972	3.49	11.2	109.	-49	16.0	1.08
27	.0146	09	.112	3.92	10.7	121.	-51	18.6	
26	.0165	08	.128	4.42	10.3	136.	-53	21.7	1.10
25	.0183	08	.147	4.92	9.6	148.	-57	25.3	
24	.0201	08	.167	5.40	9.0	162.	-57	29.6	1.19
23	.0215	07	.188	5.78	8.3	175.	-55	34.6	
22	.0231	08	.211	6.21	7.5	185.	-59	40.5	1.28
21	.0231	09	.234	6.21	6.7	181.	-57	46.3	
20	.0193	12	.254	5.19	4.7	157.	-56	54.6	1.09
19	.0143	17	.268						
18	.0116	23	.280						
17	.0102	27	.210						
16									
15									

Air Temp, Pressure Density, Data Source: Used Datasonde on 3/16/77 at 1530 GMT for 22 - 62 km. For 20-21 km and 63-65 km, used statistical results for the years 1969 - 1975 inclusive at WFC.

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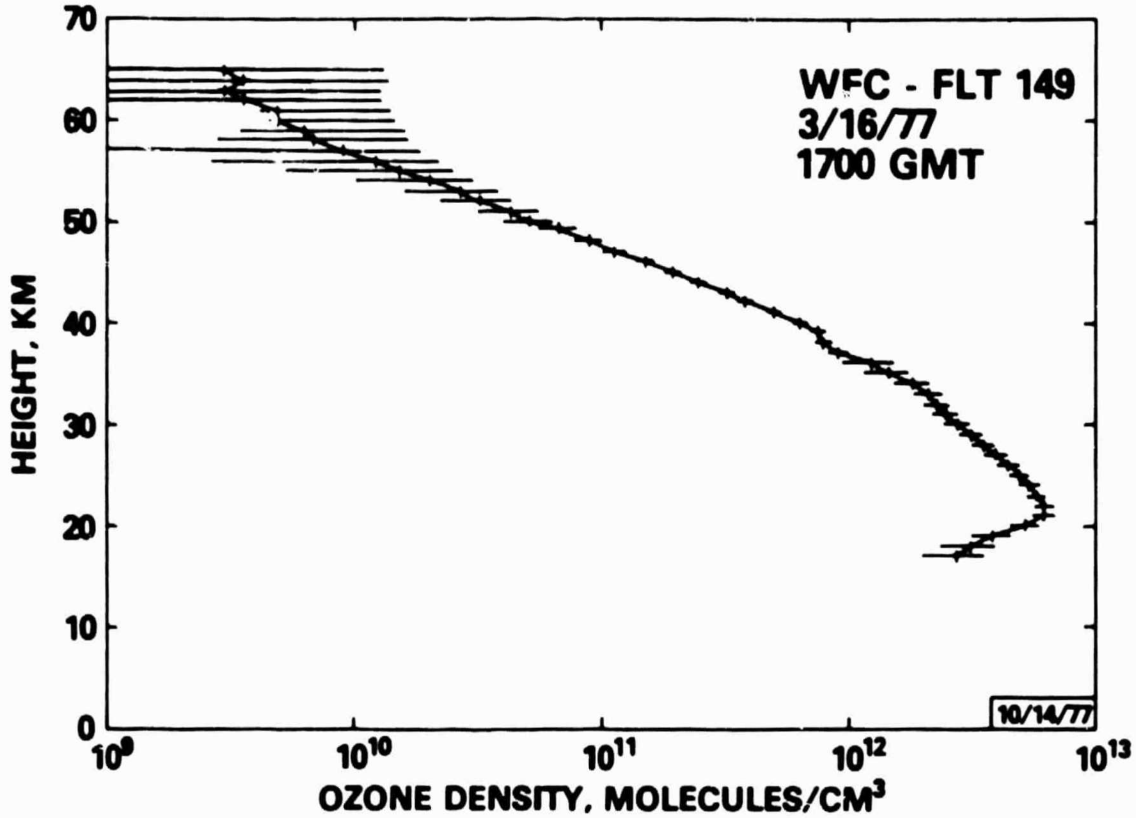

Figure 1.-Ozone Density Profile.

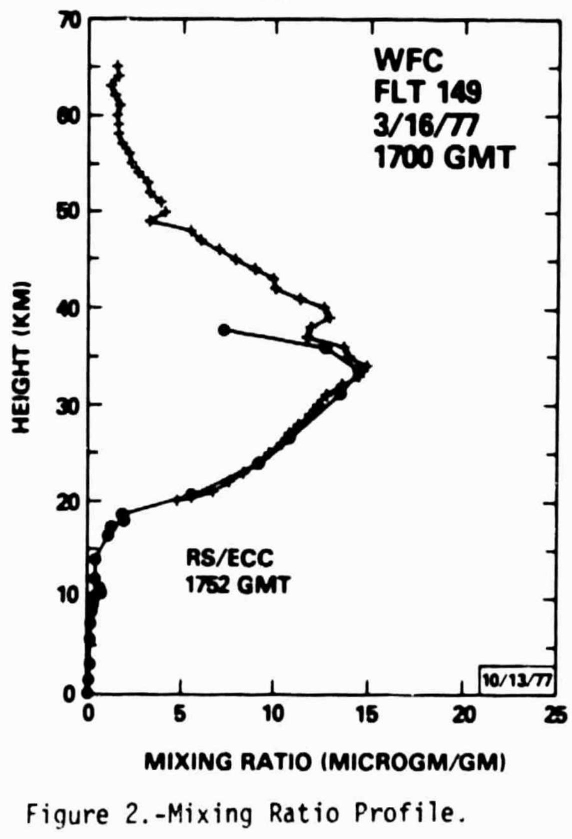

Figure 2.-Mixing Ratio Profile.

Flight No. 150 (Churchill Research Range/ World Day)

<u>Synopsis</u>.-Rocket ozone flight No. 150 was launched at 1819 GMT on March 16, 1977 and reached an apogee of 72.8 km at T+128 seconds. Ejection occurred at T+127 seconds. The telemetry signal was nominal until ejection. At ejection, all channels were masked by extreme noise. No data were recovered.

<u>Post-Flight Analysis</u>.-The post flight analysis indicated that the wide angle diffuser plate failed at ejection.

Flight System Serial Numbers: Sensor/PCM/ Starute 220/35/S14852

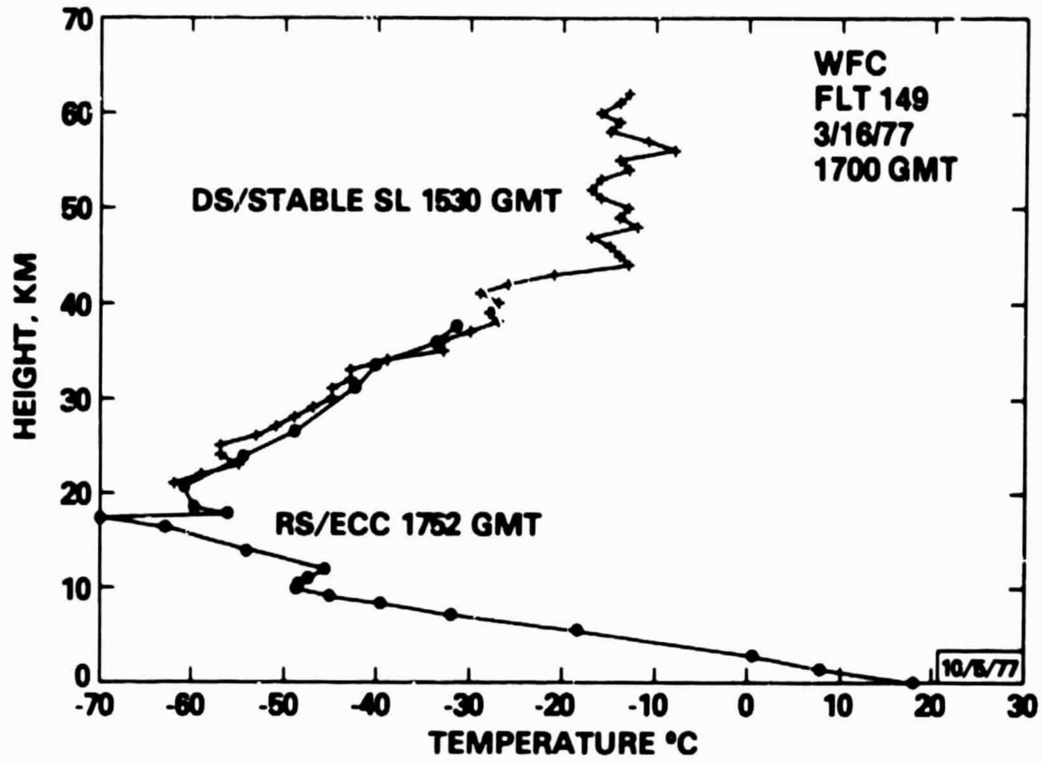

Figure 3.-Conjunctive Temperature Profile.

Flight No. 151 (Wallops Flight Center/Nimbus-4 BUV)

<u>Synopsis</u>.-Rocket ozone flight No. 151 was launched at 1440 GMT on April 1, 1977 in conjunction with the Nimbus-4 overpass at 1446 GMT. Ejection occurred at T+116 seconds. Apogee occurred at T+123 seconds at 71.8 km. The starute inflated immediately after ejection and was stable at T+155 seconds.

At about seven minutes into flight, the battery monitor, Channel 6 (word 6 in the PCM frame) began to indicate a high rate of decrease in battery voltage. The voltage monitor dropped from 5.5 volts to 4.5 volts in less than two minutes. Following this change, the sensor signals appeared normal until T+26 minutes, when the marker pulses stopped. Post flight investigation has led us to believe that one cell of the power pack failed.

An ozone profile was compiled from 22 km to 60 km after elimination of data that appeared biased by the voltage change.

The noise level throughout the flight was typically greater than ± 100 millivolts or ± 2 to 3 bits. At T+180 seconds, S_0 was 7.5 volts; S_1 was 9.1 volts; the compensation channel (Channel 3) had a mean deflection of 4.6 volts; S was 8.1 volts; S was 8.2 volts; and

the marker pulse channel (Channel 7) peak voltage was 4.1 volts. Modulation of the compensation channel (Channel 3), due to starute pendulation/coning was 5 volts to 7 volts, peak-to-peak, in the earlier portion of the flight. Short period modulation was less than 1.5 volts.

Flight Results.-Flight No. 151 was a special sounding for comparison with the Nimbus 4 BUV. It was launched at 1440 GMT and was not part of the regular monthly soundings which are flown at local noon.

The Solar Flux Values and Filter Characteristics are presented in Table IV.

TABLE IV.-SOLAR FLUX VALUES/FILTER CHARACTERISTICS FOR FLIGHT NO. 151

TM CHANNEL ($\#/S/\lambda/\Delta\lambda$)	TM (VOLTS)	$I(\infty)$	OZONE PROFILE INTERVAL (km)
$\#1/S_0/3199.1/35.8$	7.5	78	REFERENCE
$\#2/S_1/3035.6/36.4$	9.1	57	21-40
$\#4/S_2/2829.2/39.6$	8.1	24	38-50
$\#5/S_3/2587.7/137.5$	8.2	12	43-61

POLYNOMIAL COEFFICIENTS FOR α AND β

S	A_0	A_1	A_2	C_0
S_0	0.623	-0.012	0.000	0.927
S_1	5.760	-0.533	0.085	1.156
S_2	80.81	-46.609	-31.820	1.56
S_3	259.21	-1141.	-66900.	2.21

NOTE: λ and $\Delta\lambda$ are expressed in Å, $I(\infty)$ is expressed in $\mu W/cm^2/nm$.

Because of the battery malfunction noted above, the ozone data from this flight are of lower quality than normal. The voltage change appeared to affect the operation of the UV/compensation divider but did not appear to influence the UV amplifier gain. Thus, the results at altitudes below 37 km were obtained from the uncompensated S_1 signals. The data should be used with caution because additional gain changes will bias the results. Further analysis may be necessary.

Ozone densities were derived from 22 km to 60 km. In the data overlap region of the S_2 and S_3 signals (between 44 km and 49 km), the S_3 ozone densities averaged 6% less than the S_2 densities. At the single point of overlap between the S_1 and S_2 data (at 39 km),

the S_2 results were 18% higher than the S_1 densities. This is contrary to the usual situation and is probably due to the battery problem.

The composite results are listed in Table V. The probable errors are based only on the noise in the UV flux data and consequently, underestimate the true errors due to the battery failure. The integral ozone above 25.5 km is 0.155 atm-cm and the integral ozone below 25.5 km from the ECC balloon ozonesonde was 0.177 atm-cm, yielding a total ozone amount of 0.332 atm-cm. This value is 5% higher than the Dobson measurement of 0.316 atm-cm taken at 1448 GMT.

The ozone density profile, shown in Figure 4, has a constant scale height (3.5 km) between

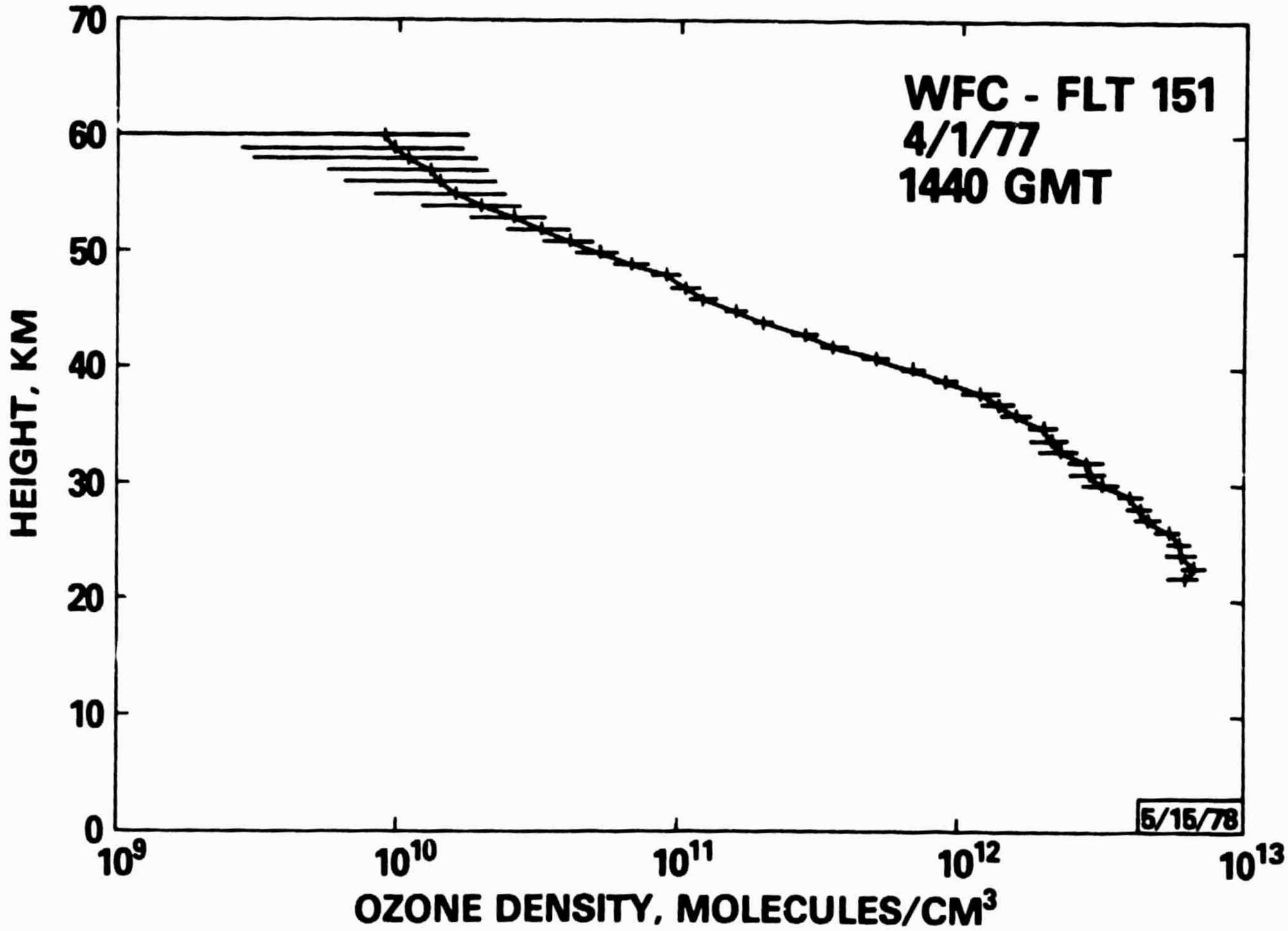

Figure 4.-Ozone Density Profile.

38 and 45 km. The scale height increases to 4.0 km near 50 km. The maximum ozone density of 6.8×10^{12} mol/cm^3 is found at 23 km. The densities are lower than the mid-Latitude Model above 40 km and higher below 40 km. The corresponding ozone mixing ratio profile, shown in Figure 5, has a maximum of 18 μg/g between 35 km and 38 km. The mixing ratio

TABLE V.-COMPOSITE RESULTS.

ROCKET OZONE DATA

Flight No 151 Location Wallops Rocket Total Ozone Above 25.5 km
Equals .155
Date 4/1/77 Experimenter A. Krueger Balloon Residual Ozone Below 25.5 km
Ser. No's: Sensor/PCM/Starute: 226/760850/S14845 Equals .177
GMT Time 1400Z Payload No 226 Total Ozone = .332
Sec Z = 1.4128
= 1.4360 Scale Height = 4.5
= 1.4482
Dobson Total Ozone = 1448Z .316; 1718Z .313; 1950Z .319

Ht km	Δx/Δh atm-cm/km	Probable Error, %	x(h) atm-cm	E(h) mol/cm³	Mixing Ratio ugm/gm	O_3 Partial Pressure umb	Air Temp °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66									
65									
64									
63									
62									
61			.00015						
60	.000033	96	.00018	8.87×10^{9}	2.4	.322	-12	.219	1.21
59	.000036	71	.00022	9.68	2.3	.352	-12	.249	
58	.000040	71	.00026	1.08×10^{10}	2.3	.389	-13	.284	.96
57	.000048	56	.00031	1.29	2.4	.467	-13	.323	
56	.000052	54	.00036	1.40	2.3	.510	-11	.367	.87
55	.000059	47	.00042	1.59	2.3	.579	-11	.417	
54	.000073	37	.00049	1.96	2.5	.711	-13	.474	.77
53	.000095	28	.00058	2.55	2.8	.921	-14	.540	
52	.00012	24	.00070	3.23	3.1	1.18	-11	.614	.84
51	.00015	19	.00085	4.03	3.5	1.48	- 9	.698	
50	.00019	15	.00104	5.11	3.9	1.89	- 8	.792	.77
49	.00025	13	.00129	6.72	4.5	2.47	- 9	.899	
48	.00033	10	.00162	8.87	5.2	3.24	-11	1.02	.86
47	.00039	10	.00201	1.05×10^{11}	5.5	3.87	- 8	1.16	
46	.00045	09	.00246	1.21	5.6	4.48	- 7	1.32	.72
45	.00059	07	.00305	1.59	6.4	5.79	-11	1.50	
44	.00074	06	.00379	1.99	7.1	7.31	- 9	1.70	.73
43	.00105	09	.00484	2.82	8.8	10.3	-10	1.93	
42	.00133	09	.00617	3.58	9.6	12.8	-16	2.20	.90
41	.00186	09	.00803	5.00	11.3	17.3	-25	2.51	
40	.00253	08	.0106	6.80	13.8	24.1	-19	2.87	1.12
39	.00327	08	.0138	9.03	15.6	31.2	-25	3.28	
38	.00442	14	.0183	1.19×10^{12}	18.0	41.2	-24	3.76	1.36
37	.00510	12	.0234	1.37	17.6	46.2	-31	4.32	
36	.00590	11	.0293	1.59	17.4	52.6	-35	4.97	1.30
35	.00739	09	.0366	1.99	18.6	65.0	-38	5.73	
34	.00783	14	.0445	2.10	16.8	67.4	-43	6.62	1.33
33	.00842	14	.0529	2.26	15.5	72.5	-43	7.66	
32	.0106	13	.0635	2.85	16.7	90.1	-46	8.88	1.40
31	.0107	13	.0742	2.88	14.4	90.1	-48	10.3	
30	.0119	12	.0861	3.20	13.7	99.8	-49	12.0	1.27
29	.0151	08	.101	4.06	15.0	127.	-49	13.9	
28	.0161	08	.117	4.33	13.5	134.	-51	16.2	1.34
27	.0173	09	.135	4.65	12.6	145.	-49.2	18.8	
26	.0203	08	.155	5.46	12.7	169.	-50.4	21.9	1.35
25	.0223	08	.177	5.99	11.8	185.	-51.6	25.7	
24	.0226	11	.200	6.08	10.4	186.	-52.7	29.5	1.34
23	.0252	09	.225	6.77	9.7	204.	-56.5	34.4	
22	.0232	12	.248	6.24	7.6	188.	-57.0	40.3	1.28
21									
20									
19									
18									
17									
16									
15									

Used Datasonde on 4/1/77 at 1533Z for WFC for 28-60 km.
Used RS/ECC at 1400Z for 22-27 km.

Air Temp, Pressure Density, Data Source

NASA WI 1961 (1-71)

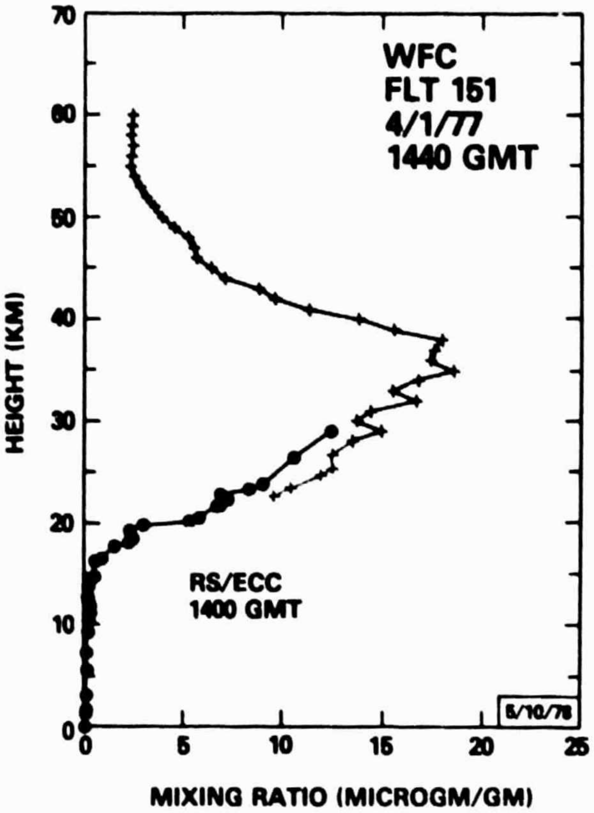

Figure 5.-Mixing Ratio Profile.

decreases to 11 μg/g near 30 km and 40 km and is 3.9 μg/g at 50 km. The conjunctive ECC balloon sounding yielded mixing ratios about 15% lower than the rocket values between 22 km and 29 km.

The air temperature distribution, Figure 6, is very similar to that on March 16, 1977 except that the levels above 40 km have warmed by about 5°C.

Flight No. 152 (Wallops Flight Center/ World Day)

Synopsis.-Rocket ozone flight No. 152 was launched at 1656 GMT. Ejection occurred at T+106 seconds with stabilization of the starute established less than twenty seconds later. Radar acquisition of target was at T+154 seconds at 48.8 km which delayed the

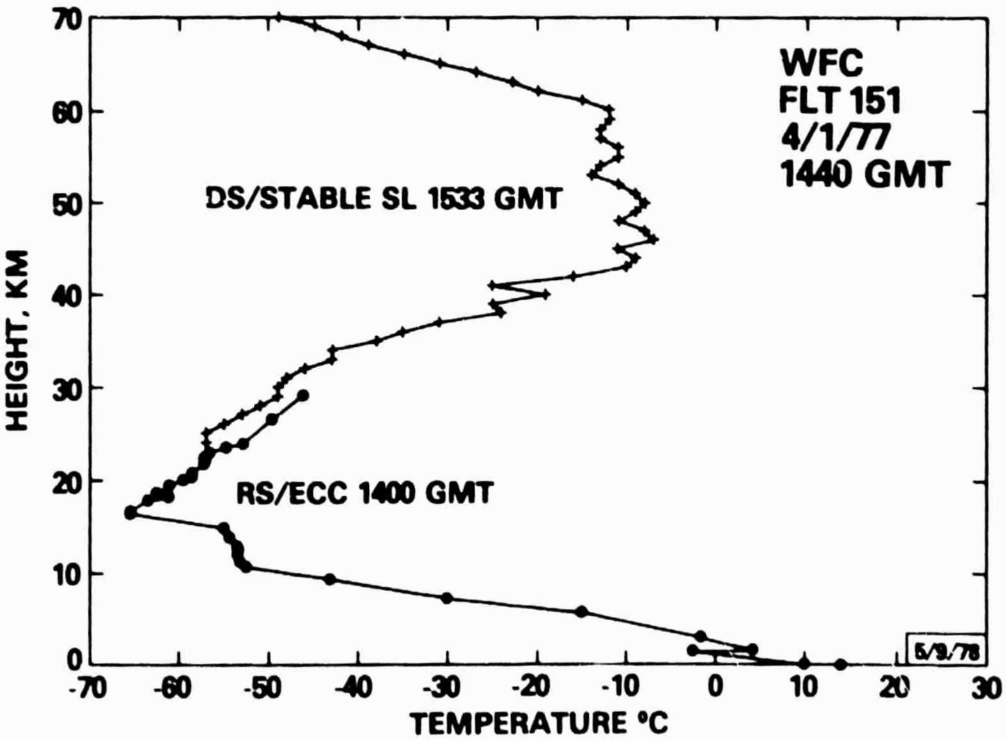

Figure 6.-Conjunctive Temperature Profile.

beginning of the reduction of ozone data until 46 km.

At T+125 seconds, S_0 was 6.3 volts; S_1 was 7.8 volts; the compensated channel (Channel 3) was 7.0 volts; S_2 was 6.1 volts; S_3 was 4.6 volts; and the marker pulse channel (Channel 7) was 4.1 volts. The noise throughout the flight was typically $\pm$ 1 bit. Modulation of the compensation channel (Channel 3), due to pendulation/coning, was 6.5 volts to 8.2 volts, peak-to-peak, early in the flight.

The pendulation did not change very much, from that observed earlier, throughout the flight until well after the usual forty-five minute flight record termination. (Telemetry was recorded for an extended period of time for diagnostic purposes.) At about one hour into flight, the peak-to-peak deflections were 5.0 volts to 8.0 volts and thirty minutes later, it was 4.0 volts to 8.0 volts. Short duration modulation was less than 1.5 volts.

Flight Results.-The Solar Flux Values and Filter Characteristics for flight No. 152 are presented in Table VI. Flight No. 152 produced an ozone profile from 17 km to 45 km.

TABLE VI.-SOLAR FLUX VALUES/FILTER CHARACTERISTICS FOR FLIGHT NO. 152

TM CHANNEL ($\#/S/\lambda/\Delta\lambda$)	TM (VOLTS)	$I(\infty)$	OZONE PROFILE INTERVAL (km)
$\#1/S_0/3200.6/36.0$	6.3	84	REFERENCE
$\#2/S_1/3033.8/35.1$	7.8	64	16-38
$\#4/S_2/2829.0/39.9$	6.1	25	35-46
$\#5/S_3/2590.9/139.5$	4.6	13	40-46

POLYNOMIAL COEFFICIENTS FOR α AND β

S_i	A_0	A_1	A_2	C_0
S_0	0.611	-0.012	0.000	0.927
S_1	5.872	-0.524	0.076	1.156
S_2	80.93	-46.33	-22.549	1.56
S_3	257.3	-1173.	-63400.	2.21

NOTE: λ and $\Delta\lambda$ are expressed in Å, $I(\infty)$ is expressed in $\mu W/cm^2/nm$.

The ozone densities from the S_3 signals average 8% less than those from S_2 signals in the overlap region (42 km to 45 km). A zero offset of 80 millivolts was removed from the S_3 signal. The S_2 derived ozone densities are 1% less than the corresponding S_1 densities at 37 km and 36 km. The composite results are listed in Table VII. The integral of the

TABLE VII.-COMPOSITE RESULTS.

ROCKET OZONE DATA

Flight No 152 Location Wallops Rocket Total Ozone Above 16.5 km
Equals .315

Date 4/20/77 Experimenter A. Krueger Balloon Residual Ozone Below 16.5 km
PCM Ser. No: 761240 Starute No: S14844 Equals .084
GMT Time 1656 GMT Payload No 227 Total Ozone = .399
Sec Z = 1.1172
= 1.1169 Scale Height = 3.9 Dobson Total Ozone = .365
= 1.1169

Ht. km	$\Delta x/\Delta h$ atm-cm/km	Probable Error, %	x(h) atm-cm	E(h) mol/cm³	Mixing Ratio ug/gm	O_3 Partial Pressure umb	Air Temp. °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66									
65									
64									
63									
62									
61									
60									
59									
58									
57									
56									
55									
54									
53									
52									
51									
50									
49									
48									
47									
46			.00197						
45	.00057	10	.00254	1.53×10^{11}	6.3	5.76	-3	1.51	
44	.00077	07	.00331	2.07	7.4	7.67	-7	1.71	.73
43	.00104	07	.00435	2.80	8.6	10.2	-11	1.95	
42	.00139	06	.00574	3.74	10.0	13.5	-14	2.21	.89
41	.00177	06	.00751	4.76	11.0	16.8	-19	2.53	
40	.00234	07	.00985	6.29	12.6	22.1	-21	2.89	1.04
39	.00287	07	.0127	7.71	13.2	26.5	-26	3.30	
38	.00352	07	.0162	9.46	14.3	32.8	-24	3.78	1.08
37	.00437	07	.0206	1.17×10^{12}	15.2	40.3	-27	4.34	
36	.00542	07	.0260	1.46	16.3	49.5	-29	4.98	1.20
35	.00661	14	.0326	1.78	17.0	59.2	-34	5.73	
34	.00782	12	.0405	2.10	17.1	68.8	-38	6.60	1.33
33	.00879	09	.0493	2.36	16.5	76.4	-41	7.63	
32	.0102	08	.0595	2.74	16.3	87.5	-44	8.83	1.35
31	.0116	06	.0711	3.12	16.0	99.9	-43	10.2	
30	.0130	05	.0841	3.49	15.4	110.	-45	11.9	1.38
29	.0141	05	.0982	3.79	14.1	118.	-49	13.8	
28	.0148	06	.113	3.98	12.7	124.	-49	16.0	1.23
27	.0160	06	.129	4.30	11.7	133.	-51	18.6	
26	.0179	06	.147	4.81	11.0	146.	-55	21.7	1.19
25	.0190	06	.166	5.11	10.1	156.	-54	25.4	
24	.0195	07	.185	5.24	8.8	160.	-54	29.6	1.15
23	.0212	06	.207	5.70	8.1	171.	-58	34.6	
22	.0218	07	.228	5.86	7.1	175.	-58	40.5	1.21
21	.0201	07	.248	5.90	5.6	161.	-59	47.4	
20	.0191	08	.268	5.13	5.3	153.	-59	47.5	1.08
19	.0184	09	.286						
18	.0155	12	.301						
17	.0131	15	.315						
16									
15									

Air Temp, Pressure Density, Data Source: Used Datasonde for Wallops Island, VA on 4/20/77 at 1552 GMT.

combined rocket and ECC balloon ozonesonde profile, joined at 16.5 km, was 0.399 atm-cm. This was 9% higher than the Dobson total ozone of 0.365 atm-cm. The ozone density profile, shown in Figure 7, exhibits a smooth decrease in scale height from the maximum at 22 km

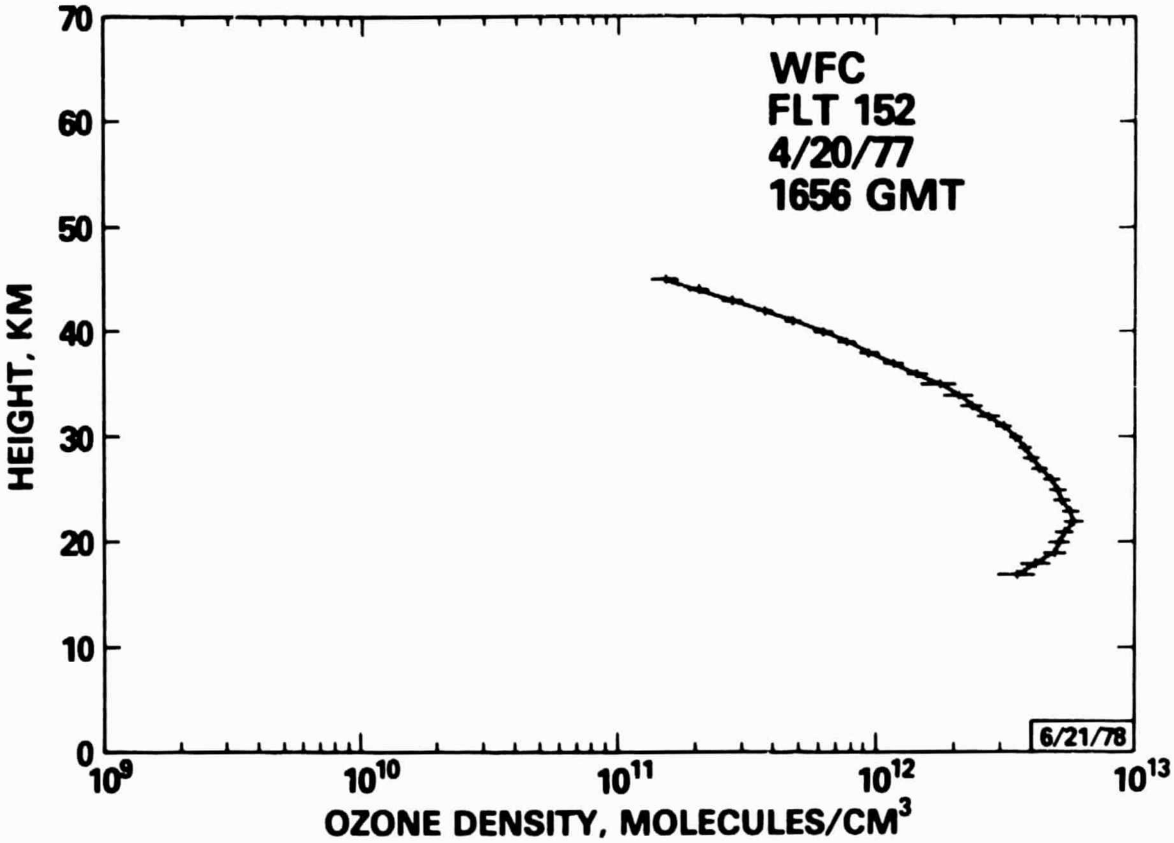

Figure 7.-Ozone Density Profile.

to the top of the sounding at 45 km. The mixing ratio distribution, Figure 8, is smooth with a peak of 17.1 μg/g at 34 km. Good agreement is found between the rocket and balloon data below 27 km. At higher altitudes, the balloon mixing ratios are less (by 11% at 30 km) and indicate a peak at 31 km.

The conjunctive temperature profile, Figure 9, has a single tropopause at 12 km, a nearly monotonic increase with altitude to 45 km and a stratopause temperature of approximately -3°C between 45 and 51 km. Compared with the March sounding, the temperatures have increased at all altitudes between 35 and 55 km. The stratopause narrowed, its height decreased by 5 km and the temperature increased by 10°C.

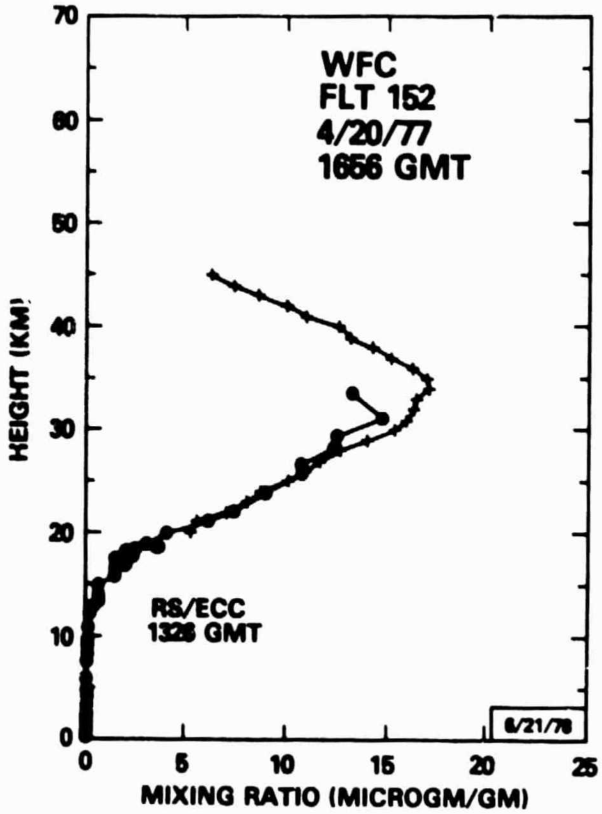

Figure 8.-Mixing Ratio Profile.

Flight No. 153 (Churchill Research Range/ World Day)

Synopsis.-Rocket ozone flight No. 153 was launched at 1800 GMT and reached an apogee of 73.1 km at T+120 seconds. Ejection occurred at apogee and the reduction of meaningful data was initiated at 62 km. The telemetry data were provided by computer readout, thus, bypassing the need to manually read the flight record.

The noise level on all channels, for the entire flight record interval of T+51 minutes, was ± 1 bit. Toward the end of the flight record, the noise occasionally reached ± 2 bits. The modulation of the compensation channel (Channel 3), due to pendulation, was generally 7 to 9 volts, peak-to-peak,

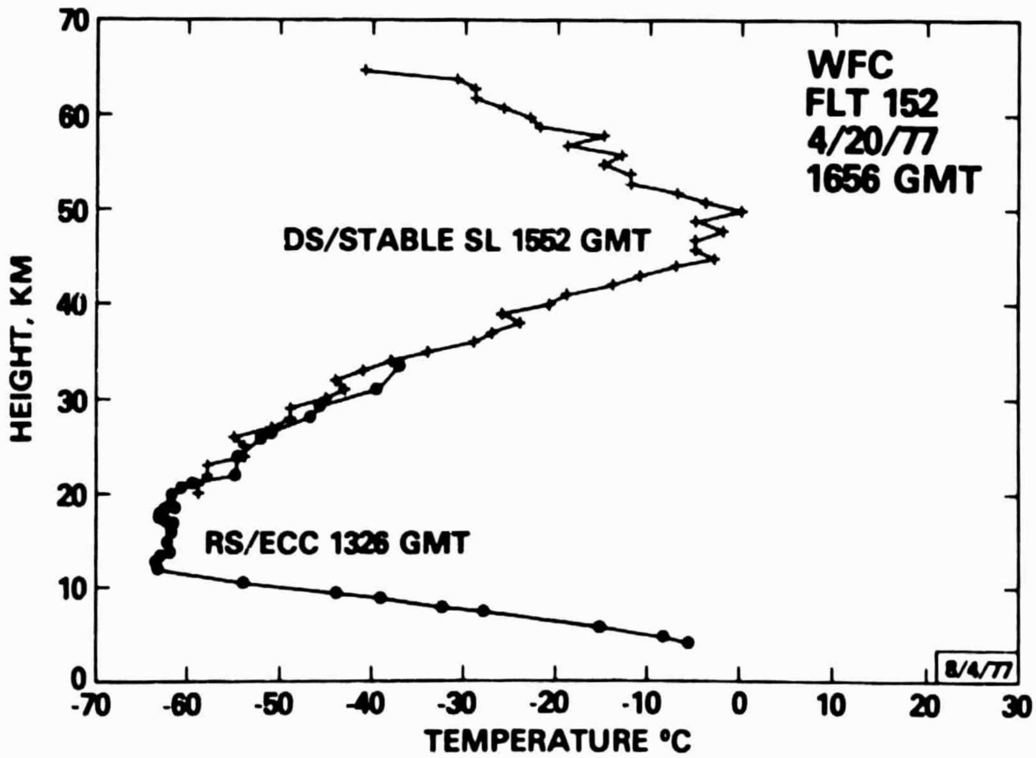

Figure 9.-Conjunctive Temperature Profile.

with occasional excursions to a range of 6.5 to 9.5 volts. At the lowest altitudes, the modulation increased to 6 to 10 volts. The flight record was clean, with no data reduction problems, from beginning to end. At the time when the starute stabilized, S_0 was 7.0 volts; S_1 was 7.2 volts; the compensation channel (Channel 3) mean value was 7.5 volts; S_2 was 6.4 volts; and S_3 was 5.8 volts.

Flight Results. The Solar Flux Values and Filter Characteristics are presented in Table VIII. Flight No. 153 is the monthly sounding for April at Churchill Research Range.

TABLE VIII.-SOLAR FLUX VALUES/FILTER CHARACTERISTICS FOR FLIGHT NO. 153

TM CHANNEL (#/S/λ/$\Delta\lambda$)	TM (VOLTS)	I(∞)	OZONE PROFILE INTERVAL (km)
#1/S_0/3203.0/36.2	7.0	81	REFERENCE
#2/S_1/3032.6/35.2	7.2	59	17-42
#4/S_2/2828.6/39.6	6.4	24	36-58
#5/S_3/2594.9/147.1	5.8	14	40-61

POLYNOMIAL COEFFICIENTS FOR α AND β

S_i	A_0	A_1	A_2	C_0
S_0	0.597	-0.021	0.014	0 927
S_1	5.978	-0.557	0.093	1.156
S_2	81.20	-47.37	-29.564	1.56
S_3	255.0	-1259.	-70200.	2.21

NOTE: λ and $\Delta\lambda$ are expressed in Å, I(∞) is expressed in $\mu W/cm^2/nm$.

The altitude range was 17 km to 61 km. Because of computer processing of the flight telemetry, it was possible to extend the regions of overlap data between filters. The overlap between S_2 and S_3 data extended from 40 to 58 km and no bias was found between the ozone densities. The overlap between S_1 and S_2 data was from 36 to 42 km and the S_2 densities were 5% less than the S_1 densities. Table IX lists the composite results. The probable errors show an improvement over the normal methods because of the large increase in data volume due to the use of all samples rather than point samples at 1 km levels. The errors in Table IX, however, represent 1 σ confidence intervals about piecewise regression lines fit to the UV data, evaluated at the kilometer levels and propagated through the ozone algorithms. Because of the 8 bit digitization, it is necessary to add about 3% to each of the probable errors, thus yielding about 4% precision below 49 km.

TABLE IX.-COMPOSITE RESULTS

ROCKET OZONE DATA

Flight No 153 Location CRR Rockel Total Ozone Above 16.5 km

Equals .305

Date 4/20/77 Experimenter A. Krueger Balloon Residual Ozone Below 16.5 km

GMT Time 1800Z Equals .159

Ser. No's: Sensor/PCM/Starute: 228/761249/S14840 Total Ozone = .464

Sec Z = 1.4759

= 1.4768 Scale Height = 4.2 Dobson Total Ozone = .442

= 1.4768

Ht km	Δx/Δh atm-cm/km	Probable Error, %	x(h) atm-cm	E(h) mol/cm³	O_3 Mixing Ratio ug/gm	O_3 Partial Pressure umb	Air Temp °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66									
65									
64									
63									
62			.00006						
61	.000015	79	.00008	4.03×10^9	1.2	.142	-20.3	.190	
60	.000023	45	.00010	6.18	1.7	.221	-11.7	.216	
59	.000027	37	.00013	7.26	1.7	.260	-15.8	.246	
58	.000034	16	.00016	9.14	1.9	.328	-15.5	.280	
57	.000050	11	.00021	1.34×10^{10}	2.5	.482	-15.7	.319	
56	.000058	10	.00027	1.56	2.5	.561	-14.8	.364	
55	.000053	10	.00032	1.42	2.1	.517	-12.4	.414	
54	.000059	09	.00038	1.59	2.0	.582	- 9.4	.470	
53	.000098	05	.00048	2.63	3.0	.978	- 6.4	.533	
52	.00014	04	.00062	8.76	3.8	1.39	- 7.9	.608	
51	.00015	05	.00077	4.03	3.5	1.48	-10.2	.687	
50	.00016	03	.00093	4.30	3.3	1.59	- 8.1	.780	
49	.00023	03	.00116	6.18	4.3	2.31	- 4.9	.885	
48	.00033	01	.00149	8.82	5.4	3.29	- 6.5	1.00	
47	.00041	02	.00190	1.10×10^{11}	5.8	4.04	- 9.8	1.14	
46	.00050	01	.00240	1.34	6.3	4.94	- 9.1	1.29	
45	.00065	01	.00305	1.75	7.1	6.34	-12.6	1.47	
44	.00085	01	.00390	2.28	8.1	8.24	-14.1	1.67	
43	.00114	00	.00504	3.06	9.5	11.0	-15.8	1.90	
42	.00144	01	.00648	3.87	10.5	13.9	-14.9	2.17	
41	.00180	01	.00828	4.84	11.3	17.0	-20.2	2.47	
40	.00226	01	.0105	6.07	12.2	21.0	-24.3	2.83	
39	.00280	01	.0133	7.53	13.0	25.7	-27.8	3.24	
38	.00337	01	.0167	9.06	13.3	30.2	-33.7	3.73	
37	.00401	01	.0207	1.08	13.6	35.5	-36.7	4.29	
36	.00483	01	.0256	1.30	14.2	42.9	-35.7	4.98	
35	.00600	02	.0316	1.61	15.3	53.1	-36.7	5.71	
34	.00689	02	.0384	1.85	15.0	60.2	-39.7	6.58	
33	.00751	02	.0460	2.02	14.0	64.6	-43.3	7.62	
32	.00868	02	.0546	2.33	13.7	73.5	-46.7	8.83	
31	.00922	01	.0639	2.48	12.4	77.4	-48.7	10.3	
30	.00966	01	.0735	2.60	11.1	80.9	-49.4	11.9	
29	.0102	01	.0837	2.74	10.1	85.2	-50.0	13.9	
28	.0110	01	.0947	2.96	9.3	91.6	-50.6	16.1	
27	.0122	02	.107	3.28	8.9	101.	-51.3	18.8	
26	.0136	01	.121	3.66	8.4	113.	-51.9	21.9	
25	.0156	02	.136	4.19	8.3	129.	-52.4	25.5	
24	.0179	01	.154	4.81	8.2	148.	-52.6	29.7	
23	.0203	01	.174	5.46	7.9	167.	-52.9	34.7	
22	.0216	01	.196	5.81	7.2	178.	-53.1	40.4	
21	.0234	01	.219	6.29	6.7	193.	-53.1	47.2	
20	.0239	01	.243	6.42	5.9	197.	-53.0	55.0	
19	.0235	01	.266	6.05	4.7	187.	-56.0	65.3	
18	.0217	01	.287	5.82	4.0	182.	-49.4	74.8	
17	.0172	01	.305	4.62	2.7	143.	-50.5	80.5	
16									
15									

Used Datasonde for 20-61 km on 4/20/77 for CRR at 1616Z.
Used ECC Balloon at 1700Z for 17-19 km.

Air Temp , Pressure Density Data Source

The integral ozone derived from the rocket and MAST balloon ozonesonde profiles, joined at 16.5 km, is 0.464 atm-cm. This value is 5% higher than the Dobson measurement of 0.442 atm-cm.

The ozone density profile, Figure 10, has a mean scale height of 4.2 km at upper levels.

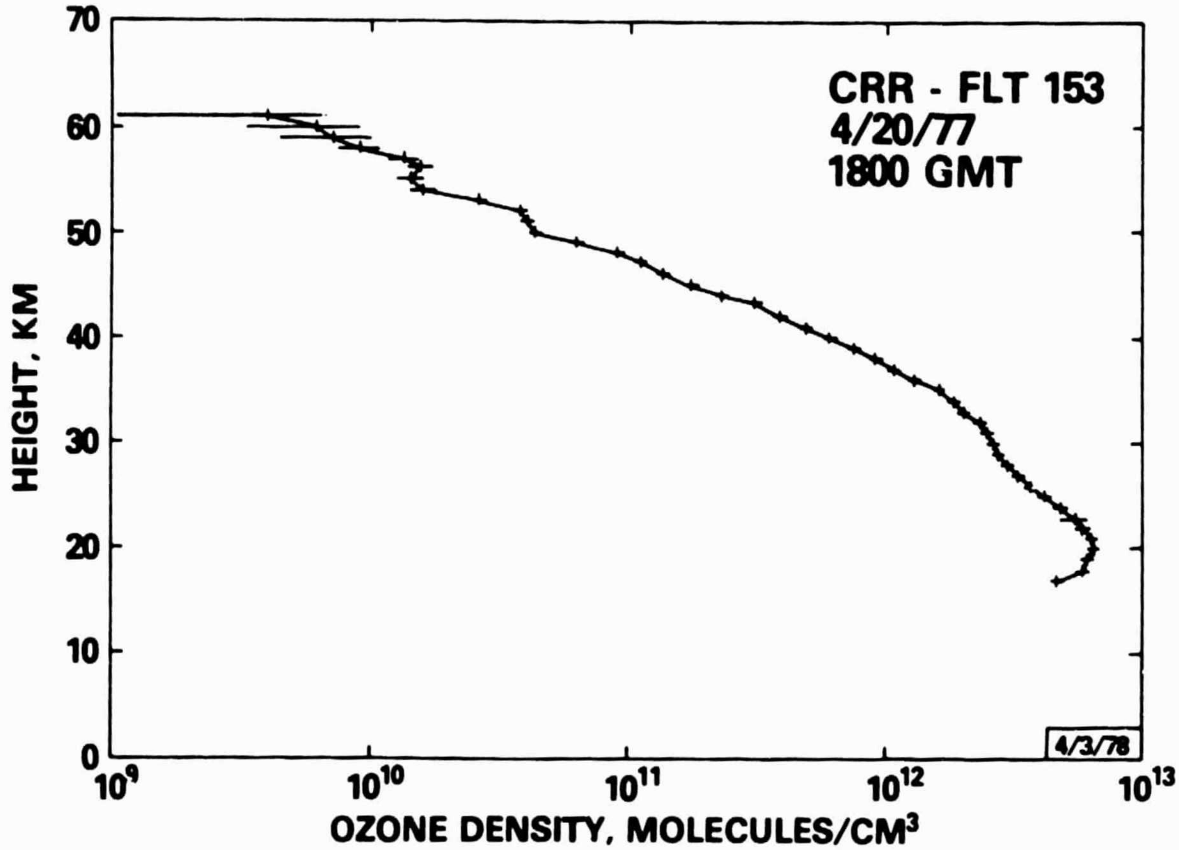

Figure 10.-Ozone Density Profile.

The profile varies smoothly with altitude except above 50 km, where some evidence for structure is found. The maximum density of 6.4 x 10^{12} mol/cm^3 is found at 20 km.

The mixing ratio profile, shown in Figure 11, has a distinct maximum of 15 μg/g at 35 km. The profile is nearly symmetric with altitude, decreasing to 11.2 and 12.2 μg/g at 30 and 40 km, respectively. The MAST balloon ozonesonde data shows agreement within 10% of the rocket data between 17 and 28 km. Compared to flight No. 152, flown at WFC on the same day, CRR has a similar profile, but smaller mixing ratios between 23 and 40 km and larger mixing ratios at other altitudes.

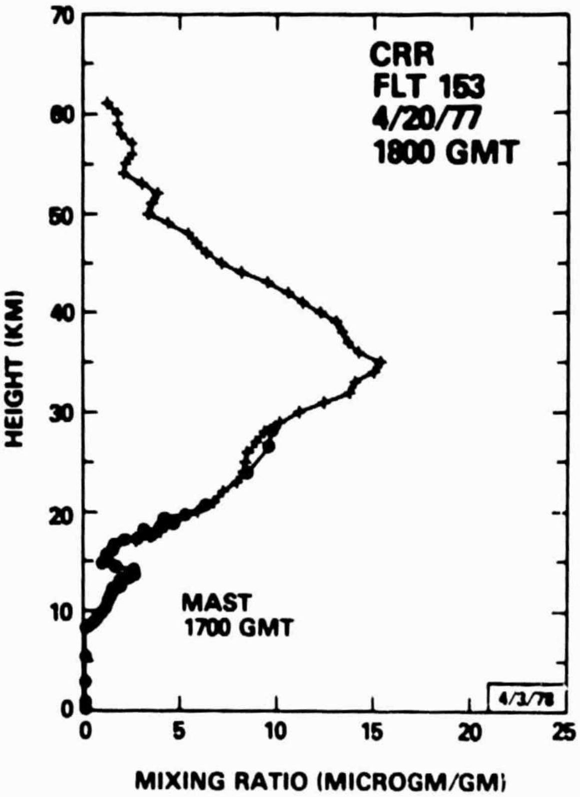

Figure 11.-Mixing Ratio Profile.

The conjunctive temperature profile at CRR, Figure 12, has a tropopause at 8 km, a small maximum below 20 km, a relatively steep gradient above 35 km and a stratopause near 50 km.

Flight No. 154 (Wallops Flight Center/World Day)

<u>Synopsis</u>.-Rocket ozone flight No. 154 was launched at 1638 GMT on May 18, 1977, and reached an apogee of 70.1 km at T+121 seconds. Ejection occurred at T+114 seconds and stabilization was established at T+150 seconds.

The noise level on all channels, for the entire flight interval of 37 minutes, was ± 2 bits. The modulation of the compensation channel (Channel 3), due to pendulation,

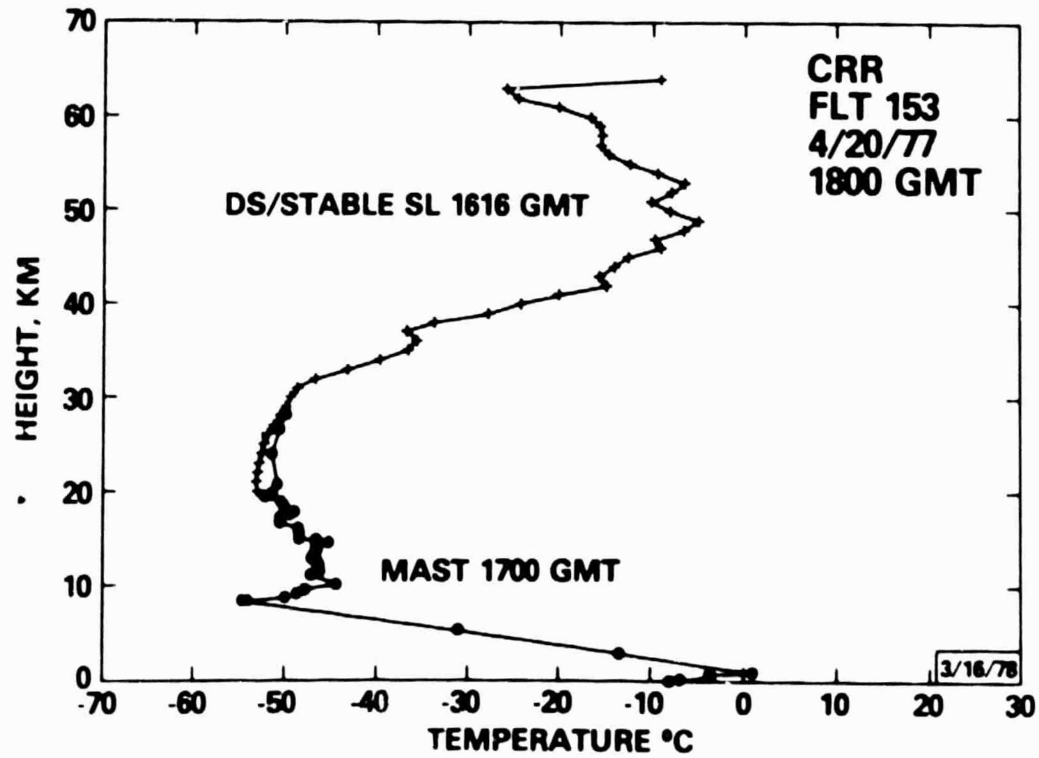

Figure 12.-Conjunctive Temperature Profile.

was 7.5 to 9.0 volts throughout the flight. The flight record was clean with no major problems during data reduction. At the time when stabilization was established, S_0 was 8.0 volts; S_1 was 8.0 volts, the compensation channel (Channel 3) indicated an average voltage of 6.0 volts; S_2 was 6.8 volts; and S_3 was 8.0 volts.

Flight Results.-The Solar Flux Values and Filter Characteristics are shown in Table X.

TABLE X.-SOLAR FLUX VALUES/FILTER CHARACTERISTICS FOR FLIGHT NO. 154

TM CHANNEL (#/S/λ/Δλ)	TM (VOLTS)	I(∞)	OZONE PROFILE INTERVAL (km)
#1/S_0/3202.0/36.0	8.0	84	REFERENCE
#2/S_1/3033.7/36.1	8.0	62	19-38
#3/S_2/2830.0/39.6	6.8	26	35-49
#4/S_3/2583.9/131.8	8.0	13	40-62

POLYNOMIAL COEFFICIENTS FOR α AND β

S_i	A_0	A_1	A_2	C_0
S_0	0.599	-0.011	0.000	0.927
S_1	5.900	-0.554	0.908	1.156
S_2	80.36	-46.12	-17.924	1.56
S_3	260.7	-1089.	-63800.	2.21

NOTE: λ and Δλ are expressed in Å, I(∞) is expressed in μW/cm²/nm.

The ozone distribution for May at WFC was determined between 20 and 61 km. The S_3 ozone densities averaged 8% less than the S_2 densities in the overlap from 41 to 48 km. The S_2 densities were 9% less than the S_1 values at 36 and 37 km. The composite results, listed in Table XI, have probable errors of 6 to 13% below 50 km. The integral ozone obtained from the rocket and ECC balloon ozonesonde data, with a transition at 19.5 km, is 0.381 atm-cm, in agreement with the Dobson total ozone of 0.387 atm-cm, within 2%.

The ozone density profile, shown in Figure 13, has a mean scale height of 4.9 km above 35 km although the scale height above 45 km is closer to 4.0 km. The maximum density of 6.1 x 10^{12} mol/cm^3 was found near 22 km. This profile has about 10% lower densities than the Mid-Latitude Model above 37 km but 40% greater densities just above 30 km.

The ozone mixing ratio profile, Figure 14, increases smoothly from 4.2 μg/g at 50 km to a pronounced maximum of 17 μg/g at 31 to 35 km, and subsequently decreases to 4.0 μg/g

TABLE XI.-COMPOSITE RESULTS.

ROCKET OZONE DATA

Flight No 154 Location Wallops Rocket Total Ozone Above 19.5 km

Equals .279

Date 5/18/77 Experimenter A. Krueger Balloon Residual Ozone Below 19.5 km

GMT Time 1638 GMT Equals .102

Ser. No's: Sensor/PCM/Starute: 230/761260/S14837 Total Ozone = .381

Sec Z = 1.054

= 1.055 Scale Height = 4.9 Dobson Total Ozone = .387

= 1.056

Ht. km	Δx/Δh atm-cm/km	Probable Error, %	x(h) atm-cm	E(h) mol/cm³	Mixing Ratio ug/gm	O_3 Partial Pressure umb	Air Temp °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66									
65									
64									
63									
62									
61	.00002	1 27	.00010	5.38×10^{9}	1.4	.182	-30	.216	
60	.00003	1 00	.00012	8.06	1.8	.277	-26	.248	1.10
59	.00003	91	.00015	8.06	1.6	.282	-22	.284	
58	.00004	71	.00018	1.06×10^{10}	1.9	.382	-18	.324	.95
57	.00006	55	.00022	1.61	2.6	.532	-14	.369	
56	.00007	50	.00028	1.88	2.7	.689	-10	.420	1.17
55	.00007	42	.00035	1.88	2.4	.699	- 6	.476	
54	.00009	34	.00042	2.42	2.8	.906	- 4	.540	.95
53	.00011	28	.00051	[illegible].96	3.0	1.12	- 2	.611	
52	.00014	23	.00062	3.76	3.4	1.43	- 0	.691	.98
51	.00017	19	.00076	4.57	3.7	1.75	[illegible]	.782	
50	.00022	15	.00093	5.91	4.2	2.27	2	.883	.89
49	.00026	12	.00115	6.99	4.4	2.67	1	.998	
48	.00033	09	.00141	8.87	4.9	3.36	- 1	1.13	.86
47	.00044	07	.00174	1.18×10^{11}	5.7	4.46	- 2	1.28	
46	.00057	06	.00219	1.53	6.5	5.72	- 5	1.45	.91
45	.00073	06	.00275	1.96	7.1	7.13	-12	1.64	
44	.00095	05	.00348	2.55	8.1	9.25	-13	1.87	.93
43	.00111	06	.00443	2.98	8.4	10.8	-12	2.13	
42	.00131	06	.00554	3.52	8.7	12.9	-11	2.42	.88
41	.00166	06	.00685	4.46	9.8	16.3	-10	2.75	
40	.00203	08	.00851	5.46	10.5	19.9	-11	3.13	.90
39	.00235	07	.0105	6.32	10.6	22.9	-13	3.56	
38	.00309	07	.0129	8.31	12.0	29.6	-17	4.06	.95
37	.00407	07	.0160	1.09×10^{12}	13.5	37.9	-24	4.64	
36	.00516	08	.0200	1.39	14.8	47.7	-26	5.31	1.14
35	.00708	13	.0252	1.90	17.6	64.9	-28	6.08	
34	.00823	13	.0323	2.21	17.1	73.3	-35	7.00	1.40
33	.00942	11	.0405	2.53	17.0	82.9	-38	8.06	
32	.0111	10	.0499	2.98	17.2	97.7	-38	9.35	1.47
31	.0127	08	.0610	3.41	16.9	111.	-37	10.8	
30	.0134	08	.0737	3.60	15.3	116.	-42	12.5	1.43
29	.0146	08	.0871	3.92	14.1	124.	-46	14.4	
28	.0159	08	.102	4.27	13.1	134.	-48	16.8	1.32
27	.0172	08	.118	4.62	12.1	144.	-50	19.5	
26	.0190	07	.1[illegible]5	5.11	11.4	158.	-51	22.7	1.27
25	.0100	07	.154	5.35	10.2	165.	-52	26.5	
24	.0224	07	.174	5.75	9.7	176.	-54	29.7	1.27
23	.0225	06	.195	6.05	8.6	186.	-52	35.8	
22	.0227	07	.218	6.10	7.4	187.	-53	41.7	1.26
21	.0212	07	.240	2.70	5.8	172.	-56	48.7	
20	.0173	09	.262	4.65	4.0	139.	-58	57.0	.97
19			.279						
18									
17									
16									
15									

Used Datasonde for 24-61 km at WFC on 5/18/77 at 1702Z. For 20-23 km used statistical results for the years 1969-1975 inclusive

Air Temp., Pressure Density, Data Source at WFC.

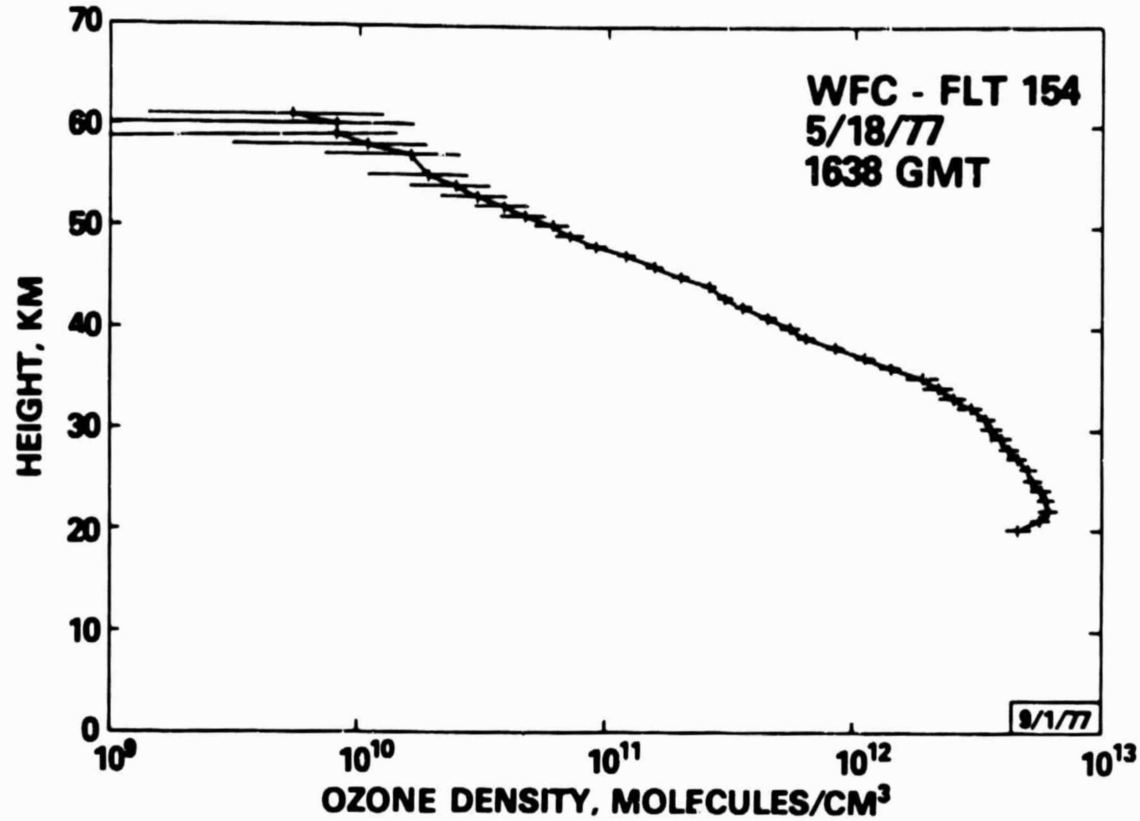

Figure 13.-Ozone Density Profile.

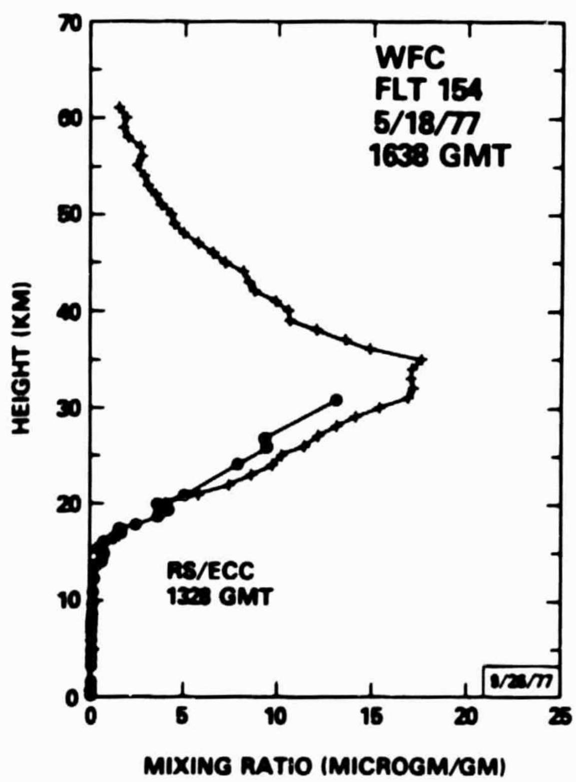

Figure 14.-Mixing Ratio Profile.

at 20 km. The agreement with the ECC balloon ozonesonde mixing ratios is poor in this case. The values are coincident at 20 km but differ by 22% at 30 km. In comparison with the April WFC flight, the profiles are quite similar. The principal differences are a lowering of the mixing ratio peak by 1 to 2 km, and a reduction in mixing ratios just above the peak.

The conjunctive temperature profile, Figure 15, has a cold tropopause at 13.5 km, a warming to a "secondary" stratopause at 41 km, and a primary stratopause at 50 km. These May temperatures tend to be 4-5°C warmer than the WFC April temperatures except for the local minimum near 45 km, where they are 2-9°C cooler.

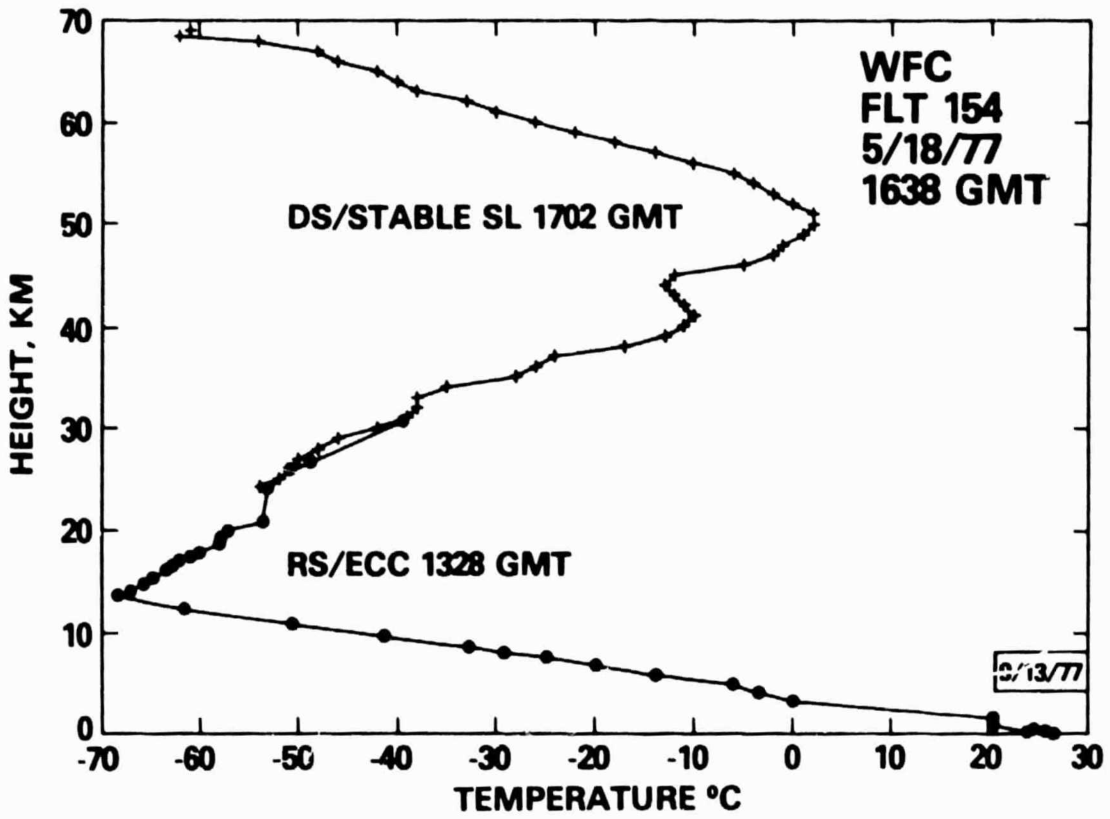

Figure 15.-Conjunctive Temperature Profile.

Flight No. 155 (Churchill Research Range/World Day)

Synopsis.-Rocket ozone flight No. 155 was launched at 1813 GMT on May 18, 1977, and reached an apogee of 70.4 km at T+123 seconds. Stabilization was established at T+165 seconds. Radar track was terminated at T+44 minutes.

This flight has a relatively poor signal to noise ratio, a fact that seems characteristic of CRR in this calendar interval. The compensation channel (Channel 3) is in and out of saturation throughout the entire flight. Word 8 indicates, on the real time CRR flight paper record, that S_1 was saturated at the 5.8 volt level during the early portion of the flight. There are reasons to believe that S_0 is saturated at the 7.2 volt level. This is due to erroneous calibration procedures.

Flight Results.-The Solar Flux Values and Filter Characteristics are shown in Table XII.

The May soundings at CRR produced ozone data from 27 to 60 km. The telemetry data have been digitally processed thus resulting in relatively broad regions of redundancy between filters. The S_3 ozone data average 9% less than the S_2 data in the 40 to 59 km overlap.

TABLE XII.-SOLAR FLUX VALUES/FILTER CHARACTERISTICS FOR FLIGHT NO. 155

TM CHANNEL (#/S/λ/$\Delta\lambda$)	TM (VOLTS)	I(∞)	OZONE PROFILE INTERVAL (km)
#1/S_0/3196.5/35.9	7.5	81	REFERENCE
#2/S_1/3029.0/35.3	7.2	56	27-47
#4/S_2/2828.5/39.7	6.7	28	33-59
#5/S_3/2589.1/140.1	6.8	13	40-60

POLYNOMIAL COEFFICIENTS FOR α AND β

S_i	A_0	A_1	A_2	C_0
S_0	0.646	-0.013	0.000	0.927
S_1	6.281	-0.602	0.108	1.156
S_2	81.03	-47.98	-52.461	1.56
S_3	256.00	-1328.	-77600.	2.21

NOTE: λ and $\Delta\lambda$ are expressed in Å, I(∞) is expressed in $\mu W/cm^2/nm$.

If the upper 4 km of this overlap are deleted, the discrepancy is reduced to 3%. The S_2 results average 4% less then S_1 data in their overlap between 33 and 47 km. The original data analysis shows a strong pertubation in the ozone profile below 40 km, with a minimum at 37 km and a maximum at 35 km. This corresponds to the time when the S_1 signal came out of saturation in the preamplifier. For this reason, and physical arguments, the analysis has been deleted between 35 and 38 km and replaced with logarithmically interpolated data.

The composite results, including the interpolated or smoothed data, are listed in Table XIII. The error estimates, as with flight No. 153 results, do not include digitization errors and, therefore, should be increased by about 3%. The total ozone determined with the Dobson was 0.371 atm-cm. The integral ozone, obtained by merging the rocket profile with the conjunctive MAST balloon ozonesonde at 26.5 km, is 0.385 atm-cm, 4% greater than the Dobson total.

A plot of the ozone density profile is shown in Figure 16. The average scale height above 39 km is 4.5 km. The interpolated region is indicated with a dashed line from 35 to 38 km. The maximum density was found below the 27 km base of the rocket sounding. The balloon profile has an ozone maximum at 20 km for this day.

TABLE XIII.-COMPOSITE RESULTS.

ROCKET OZONE DATA

Flight No 155 | Location CRR | Rocket Total Ozone Above 26.5 km Equals .112

Date 5/18/77 | Experimenter A. Krueger | Balloon Residual Ozone Below 26.5 km Equals .273

GMT Time 1813Z

Ser. No's: Sensor/PCM/Starute: 231/761255/S14836 | Total Ozone = .385

Sec Z = 1.2934
= 1.2920
= 1.2920

Scale Height = 4.5

Dobson Total Ozone = .371

Ht km	Δx/Δh atm-cm/km	Probable Error, %	x(h) atm cm	E(h) mol/cm³	Mixing Ratio ugm/gm	O_3 Partial Pressure umb	Air Temp °C	Air Pressure mb	Ratio E(h) to Model
70									
69									
68									
67									
66									
65									
64									
63									
62									
61			.00007						
60	.000015	49	.00008	4.03×10^{9}	1.0	.146	-13	.250	
59	.000014	37	.00010	3.76	.8	.136	-13	.284	
58	.000019	26	.00012	5.11	.9	.186	-12	.323	
57	.000024	20	.00014	6.45	1.1	.239	-7	.367	
56	.000034	14	.00017	9.14	1.4	.345	-2	.416	
55	.000064	09	.00024	1.72×10^{10}	2.3	.645	-4	.471	
54	.000091	07	.00033	2.45	2.8	.920	-3	.534	
53	.00012	06	.00045	3.23	3.3	1.22	-2	.605	
52	.00014	05	.00059	3.76	3.5	1.44	2	.684	
51	.00017	04	.00076	4.57	3.7	1.76	4	.772	
50	.00021	03	.00097	5.64	4.1	2.16	2	.873	
49	.00027	03	.00124	7.26	4.6	2.76	0	.987	
48	.00033	02	.00157	8.87	4.9	3.36	-1	1.12	
47	.00042	02	.00199	1.13×10^{11}	5.5	4.20	-6	1.27	
46	.00053	02	.00252	1.42	6.1	5.31	-5	1.44	
45	.00066	01	.00318	1.77	6.7	6.65	-4	1.63	
44	.00083	01	.00401	2.23	7.4	8.33	5	1.85	
43	.00108	01	.00509	2.90	8.4	10.7	8	2.09	
42	.00138	01	.00647	3.71	9.3	13.5	12	2.38	
41	.00173	01	.00820	4.65	10.2	16.7	-15	2.71	
40	.00218	01	.0104	5.86	11.1	20.8	18	3.03	
39	.00293	02	.0133	7.88	12.7	27.4	23	3.53	
*38	.00349	05	.0168	9.39	13.1	32.4	25	4.05	
*37	.00418	06	.0210	1.12×10^{12}	13.7	38.7	26	4.64	
*36	.00487	03	.0259	1.31	13.7	44.5	29	5.33	
*35	.00585	02	.0317	1.57	14.2	52.8	32	6.12	
34	.00678	02	.0385	1.82	14.1	60.7	34	7.05	
33	.00794	02	.0464	2.13	14.2	70.2	37	8.13	
32	.00976	01	.0562	2.62	15.1	86.2	37	9.39	
31	.0105	02	.0667	2.82	13.9	91.6	40	10.8	
30	.0100	02	.0767	2.69	11.3	86.5	42	12.5	
29	.0111	02	.0878	2.98	10.7	94.8	45	14.5	
28	.0122	02	.100	3.28	10.0	103.	48	16.9	
27	.0124	02	.112	3.33	8.7	104.	50	19.7	
26									
25									
24									
23									
22									
21									
20									
19									
18									
17									
16									
15									

Used Datasonde on 5/18/77 at 1644Z for CRR.

Air Temp. Pressure Density Data Source *All data for these levels, except for the air temperature and air pressure, are **smoothed values**.

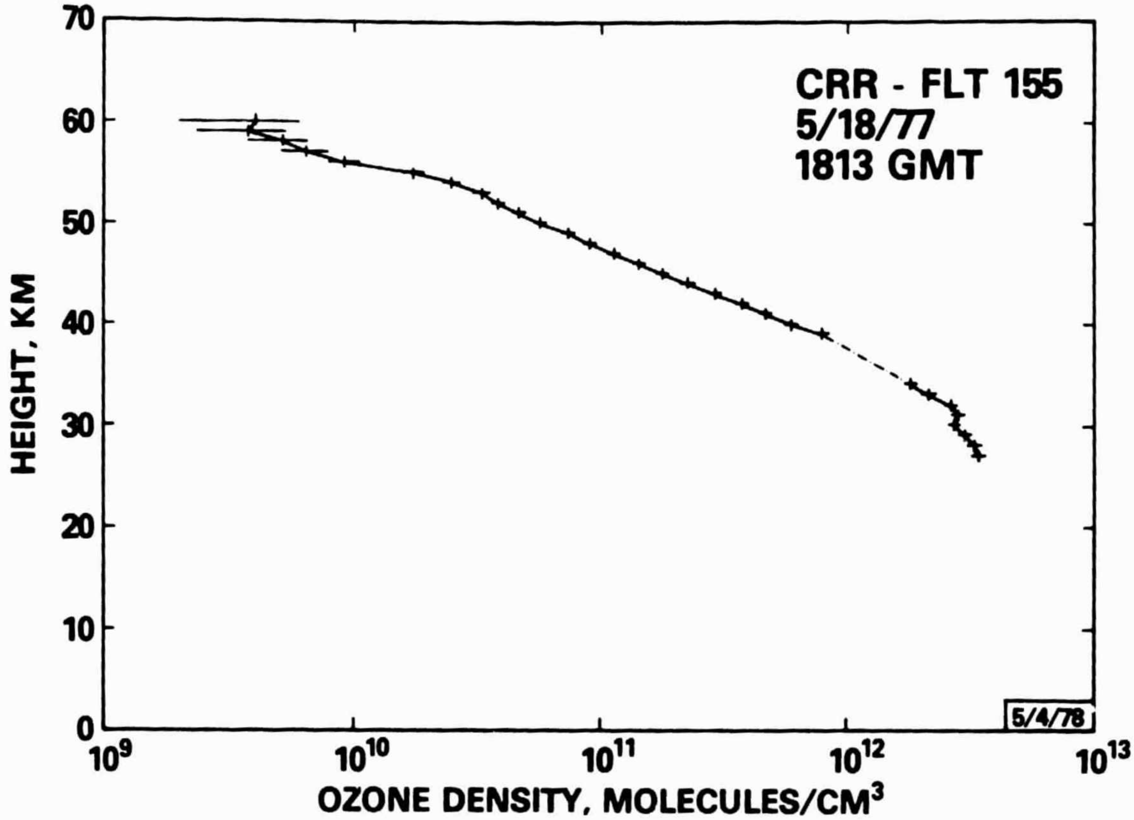

Figure 16.-Ozone Density Profile.

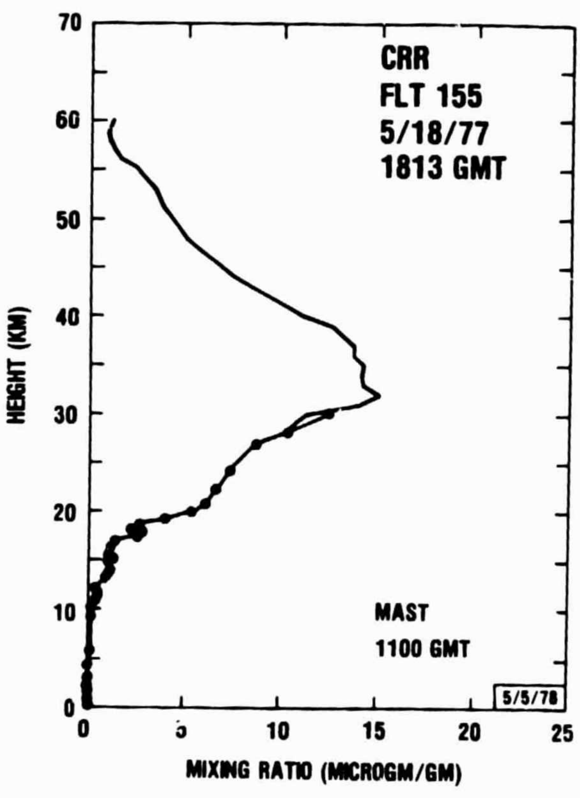

Figure 17.-Mixing Ratio Profile.

The mixing ratio profile, Figure 17, has a maximum of 15 μg/g at 32 km although the peak tends to be broad. This profile is quite close to the April distribution with only a small lowering of the center-of-gravity in May. Between 40 and 55 km, the mixing ratios are very close to those observed at WFC on the same day. Below 35 km, however, the CRR values are significantly lower. For example, at 30 km, the CRR mixing ratio is 35% less than that at WFC.

The CRR conjunctive temperature profile, shown in Figure 18, has an almost monotonic increase from -51°C at 26 km to a +4°C at 51 km stratopause. This profile is nearly the same as the WFC profile for the same day. The primary difference is in the

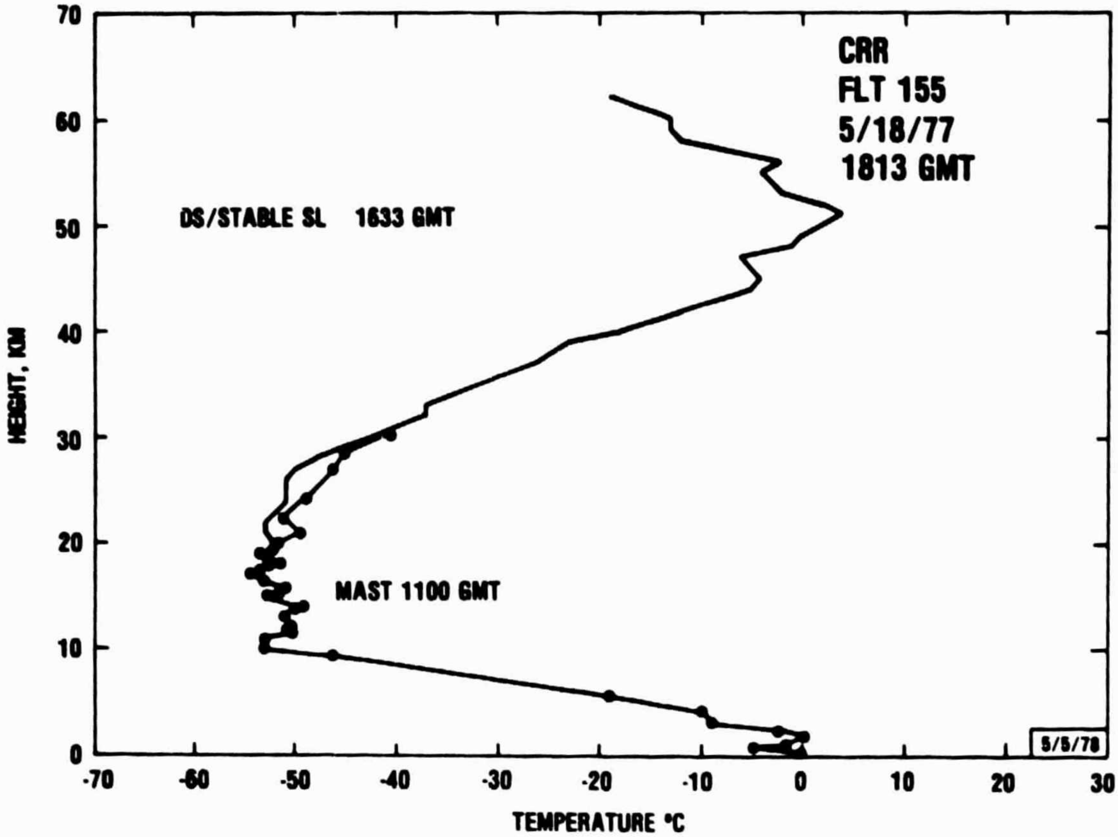

Figure 18.-Conjunctive Temperature Profile.

location of the secondary stratopause at 45 km at CRR versus 41 km at WFC.

SUMMARY

The flights reported in this volume are six regular ozone soundings from Wallops Island, Virginia and Churchill Research Range, Manitoba, Canada and one special sounding from WFC for Nimbus 4 BUV support.

During this springtime season, the WFC noon ozone mixing ratio profiles have maxima near 34 km with peak values increasing from 15 μg/g in March to 17 μg/g in April and May. This increase is accompanied by increases at lower altitudes and decreases at higher altitudes, resulting in a lowering of the center-of-gravity of the distribution. The ozone density maximum, on the other hand, rises slightly during this time period from about 21 km in March to about 22 km in April and May. Above the stratopause, the ozone appears constant or slightly increasing as summer approaches.

The Nimbus support flight on April 1, 1977, was launched 2 hours and 20 minutes before noon and, therefore, should be considered separately from the climatological series because of suspected diurnal variations in ozone. The mixing ratios are close to the April 20, 1977 values above 40 km and below 35 km but exhibit 20% larger values near 38 km.

The Churchill Research Range ozone mixing ratio profile during April (March data are not available) has a maximum at 35 km, considerably lower than the 38 km peak observed in February. By May, the maximum may have descended to 32 km although no information was obtained between 34 and 39 km, and other peaks may exist at those altitudes. The April and May profiles exhibit small seasonal increases near 30 and 50 km and decreases between 40 and 48 km. Compared with the February sounding, the April and May profiles show much larger increases between 45 and 55 km and between 30 and 36 km.

In comparison with the WFC April and May soundings, the CRR mixing ratios are nearly the same above 40 km, but significantly lower below 35 km. At 30 km, the CRR mixing ratio was 27% less than the WFC value.

These data were taken in the first quarter of the second year of regular soundings at Wallops Island.